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NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Operations/Human Performance Group Chairmen
US Airways A320 Training Manual 15.9
AQP and CRM

(5 Pages)

Attachment 21

to Operations / Human Performance Group Factual Report

DCA09MA026

**US AIRWAYS A320 TM 15.9
AQP AND CRM**

15.9 AQP and CRM (Threat and Error Management)

Threat and Error Management (TEM).

The Threat & Error Management module is intended to fully integrate technical and CRM skills.

A. Learn to Actively Assess conditions for threats (e.g., high task loading and crew factors) and errors so that any consequences can be mitigated and/or additional barriers erected to maintain a safe operating margin. At least one pilot should always be monitoring during low workload and both pilots should be monitoring as much as possible during high workload and in areas of vulnerability. Think if what you are doing, or are about to do, is sensible? (E.g., A clearance to descend to 2000 ft. 40 miles out of Charleston SC versus Charleston WV.)

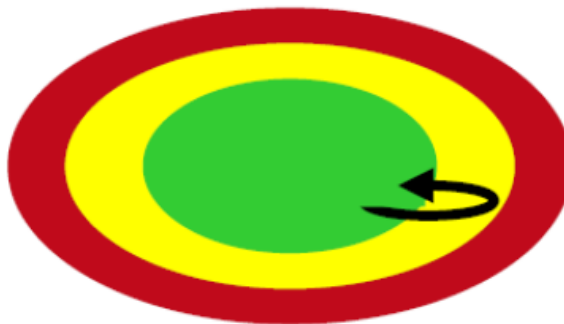
B. Understand the concept of managing available resources to Balance "Barriers" to errors.

C. Learn to effectively Communicate any threats and errors along with strategies to minimize their effects.

S. Understand the importance of following SOPs. Crews who intentionally erred by not following SOPs were 1.8 times more likely to commit another error. SOPs establish a consistent baseline for performance.

The Threat & Error Management Model uses both an acronym (ABCs) and a simple graphic to provide crews with a method to visualize and remember the threat and error management concepts. The model uses a green-yellow-red "target" to help crews visualize the potential for error. These three colors provide an easy way for the crew to communicate their perceived margin of safety and identify the need to take action. Ineffective use of the ABCs can quickly get you in the red. Effective use of the ABCs will help identify threats and errors to keep you in the green, or return you to the green.

- In the central green area, resources are used in a way to easily recognize and/or correct errors.
- In the middle yellow band, errors will occur and some may be ignored or not recognized but the errors are small and margin of safety remains adequate. Application of the ABCs will quickly get the crew back in the green.
- In the outer red band, errors will occur and not be caught. The errors become cumulative and the margin of safety is inadequate. Accomplishment of the ABCs by both pilots is vital to reestablish an adequate margin of safety.



Threats.

Threats are anything that increase the potential for error. Some examples of obvious threats are weather, ATC and aircraft malfunctions. Two not so obvious threats are crew factors and task loading which are discussed below.

Crew Factors.

Crew factors include such items as boredom, distraction, hunger, drowsiness, stress, illness, and attitudes. These physiological and psychological elements of the crew can have a double impact:

1. They may increase the crew's workload, or
2. They may simply increase the likelihood an error will occur. During periods of high task loading crew experience can also impact the potential for error.

Task Loading.

Another threat that may increase the potential for error (and impact the margin of safety) is task loading. Task loading is simply a ratio of the number of tasks that need to be performed to the amount of time available for doing them (More tasks with Less time = High Task Loading). Recognition of task loading is important in that the tendency toward error increases as task loading increases. Crews should be aware that different phases of flight naturally have different levels of task loading (i.e., the task loading during pre-departure is much higher than during cruise). Also, every flight provides threats which increase the pilots' task loading. Crew awareness of task loading is important because it is directly related to the possibility errors may occur. During periods of high task loading the crew should ensure they are balancing available resources to eliminate or capture errors. Conversely, if a crew notices errors are being made, they may want to evaluate the task loading status to determine if they need to make adjustments in workload management.

Simply put:

$$\text{Task loading} = \frac{\text{Number of tasks}}{\text{Amount of time available}}$$

Errors. .

We all acknowledge errors occur, but we must also realize how difficult it is to detect these errors. Error detection is a direct reflection of our monitoring skills.

- An NTSB study showed 84 percent of the reviewed accidents involved inadequate crew monitoring or challenging.
- A Flight Safety Foundation's Approach and Landing Accident Reduction study showed 63% of the reviewed accidents involved inadequate monitoring and crosschecking.
- Data collected in over 3000 Line Operations Safety Audits (LOSA) showed 62% of errors went undetected by flight crew.

• Note •

Errors must be detected before they can be corrected!

Managing Threats & Errors Using The ABCs.

A Actively Assess Conditions For Threats And Errors. First you must actively monitor conditions to detect any threats and errors. This is not an easy task. We just highlighted several studies demonstrating that humans are not naturally good monitors.

During low workload, boredom can cause neither pilot to monitor the aircraft effectively. It may be better to take turns monitoring, but at least one pilot must monitor the aircraft at all times. Lack of monitoring during low workload periods has caused numerous accidents and incidents.

High workload and flight path change areas can put you in the yellow or red quickly if not managed properly. Both pilots must actively monitor as much as possible during high workload and when the flight path is changing (start of climb/descent, level off, course change, FMS entries, etc.) as shown in yellow to the right.

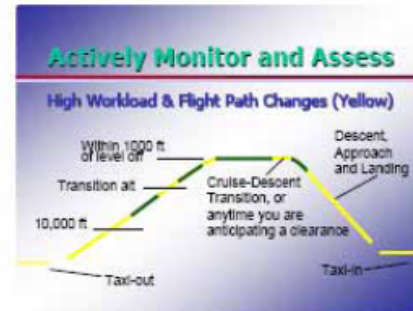
Defer non-essential items to lower workload phases (shown in green areas to the right) when possible.

During high workload and flight path changes guard against fixation. Maintain the big picture! Neither pilot should become fixated on a single item/task (loading FMS, non normal indication, etc.). Cross-checking is good but for short periods. The FOM states that the PF will monitor/control the aircraft regardless of the level of automation employed and the PM will monitor the aircraft and actions of the PF.

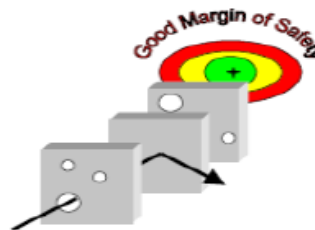
How Well Are You Monitoring? One of the first clues you are not monitoring effectively is missing the 1,000 to level off callout.

Now You Can Assess the Situation. Along with actively monitoring you must actively assess the situation and ask if what you are doing, or about to do, is sensible. Include any identified threats and errors in this assessment.

B Balance Available “Barriers” to Errors. US Airways operating environment (as detailed in the FOM and Pilot Handbooks) provides multi-layer resources to increase the likelihood errors will be recognized and corrected before they have a chance to become cumulative.



- Barriers represent resources available to the pilots
- Balancing the use of these resources decreases the chance an error will escape detection and impact the margin of safety
- Barriers can have holes in them created by threats and errors
- When an error passes through one barrier but is stopped by another barrier, the error is trapped
- Multiple barriers increase the likelihood errors will be trapped
- Both pilots need to put up barriers. With one pilot out of the loop, barriers are cut in half



Using the Barriers often requires an investment in terms of TIME. Pilots must Balance the use of resources with the available time to maintain the optimal level of redundancy.

If you increase available time (slow down or plan ahead), you decrease task loading and improve your margin of safety. Accomplish tasks during low workload periods that don't have to be performed during high workload periods. Lastly, you can decrease task loading by delegating some of the tasks to the other pilot and other resources available.

C Effectively Communicate Threats And Intentions. Communication is defined as sharing, and listening to, timely and relevant information in a way that is easily understood and keeps everyone at the same level of awareness.

After assessing the situation, communicate threats and intentions to:

- Make sure everyone is "on the same page"
- Raise the situational awareness of the crew to help maximize barriers

Research shows that the way a crew communicates can be a predictor of the way the crew performs. In short, crews who communicated better were also those crews who made fewer errors. Improved performance (i.e., fewer errors) was associated with crews who showed an increased number of:

- commands
- inquiries
- acknowledgements
- verbal observations about flight status

Instead of hinting and hoping that the other pilot recognizes a threat, effectively communicate by including:

- an opening, *John,*
- statement of concern, *I'm concerned*
- statement of the problem, *It's been 30 minutes since we deiced and it is snowing hard*
- a proposed solution, *and I think we should deice the aircraft again*
- achieving agreement *What do you think?*

Keep in mind communication patterns may need to change depending on whether a pilot is in the green, yellow or red. In the green, when crews have more situational awareness, a variety of communication styles can be effective. When pilots move into the red, they tend to get "tunnel vision", therefore, communication must become much more directive.

Crew Briefings.

Departure Briefing and Approach Briefing provide excellent opportunities to assess the situation, balance available barriers and communicate threats, errors and intentions. In addition, any time threats and errors are detected the ABCs should be accomplished.

S Follow SOPs.

The key to high performance is to put as much predictability as possible into a situation. This reduces the mental workload and provides a better foundation for effective crew coordination. In addition the predictability of normal situations will help pilots handle non-normal situations, such as recognizing when another pilot is "out of the loop." SOPs establish a consistent baseline for performance. SOPs are carefully designed by the company to create redundant barriers when necessary and to equalize workload as much as possible. Following SOPs is such an important barrier to error it has been given its own letter in the ABCs.

Threat & Error Management Summary (ABCs).**Actively Monitor and Assess.**

- During low workload: at least 1 pilot monitoring
- During high workload and flight path changes: both pilots monitoring. Guard against fixation
- Actively Assess if what you are doing, or about to do, is sensible
- Reassess whenever a threat or error is discovered

Balance Available Barriers.

- Multiple barriers = layers of defense = greater margin of safety
- Include everyone who can add barriers (PF, PM, ATC, Jumpseat Rider, F/A, etc.)
- Time is one of your most valuable barriers
 - To reduce task loading: increase available time (plan ahead or slow down), move non-essential tasks to a lower workload period, or delegate tasks to the other pilot and/or other resources available

Communicate Threats, Errors & Intentions.

- Communicate clearly and effectively to:
 - Make sure everyone is "on the same page"
 - Raise the situational awareness of the crew to help balance available barriers

Follow SOPs.

- Makes it easier to identify deviations
- Allows crewmembers to concentrate on issues not covered by SOPs
- Establishes a consistent baseline for performance

